
Space Weather Technical Forecast

Issued on Friday 4 October 2024 at 01:30 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: R1-R2 Blackouts expected, chance of further R3 Blackouts. G1-G2/Minor-Moderate Geomagnetic storms likely, Chance G3/Strong storm days 3 and 4.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been High, with the background X-ray flux just below M-class level, and several M-class flares occurring. The largest flare was a X9 flare observed at 03/1218 UTC, which originated from AR3842 near south-centre disc.

There are currently nine active sunspot regions on the visible disc, of which eight are numbered. AR3842 and AR3844 are the most complex, with beta-gamma-delta configurations, with AR3844 also showing growth in penumbra through the period which resulted in two small delta spots forming. The largest region on the disc is AR3848, but the region is close to the northeast limb which means confidence is low for its classification due to the viewing angle. Another region also tricky to analyse, due to its proximity to the east limb, is a new region that appears to have the potential to be magnetically complex.

A filament eruption was observed 03/0630 UTC in SDO/AIA 304 and GONG imagery, close to AR3848 in the northeast. This has produced a CME off the northeast limb, which has been analysed as missing Earth.

The X9.0 flare from AR3842 produced a CME, which is forecast to reach Earth late on the 4th Oct or early on the 5th.

Solar Wind / Geomagnetic Activity: Solar wind parameters were indicative of a slow regime. Solar wind speeds ranged between approximately 310 and 390 km/s. Density was below average. The Interplanetary Magnetic Field, Bt, was predominantly at weak levels, but briefly peaked at Moderate levels reaching 9nT at 03/1733 UTC. The north-south component Bz, remained at weak values below +/-6nT. Phi angle was negative (towards the Sun). Geomagnetic activity was Quiet (Kp 1-2).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 was at background levels. High energy electron flux (greater than 2MeV) observed by GOES16 was at background to moderate levels (at diurnal peak), with a peak value of 268 pfu at 03/1330 UTC. The associated 24-hour fluence was below the Active threshold. The 04/0000 UTC observation was 5.46e6 integrated pfu.

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Four-Day Space Weather Forecast Summary

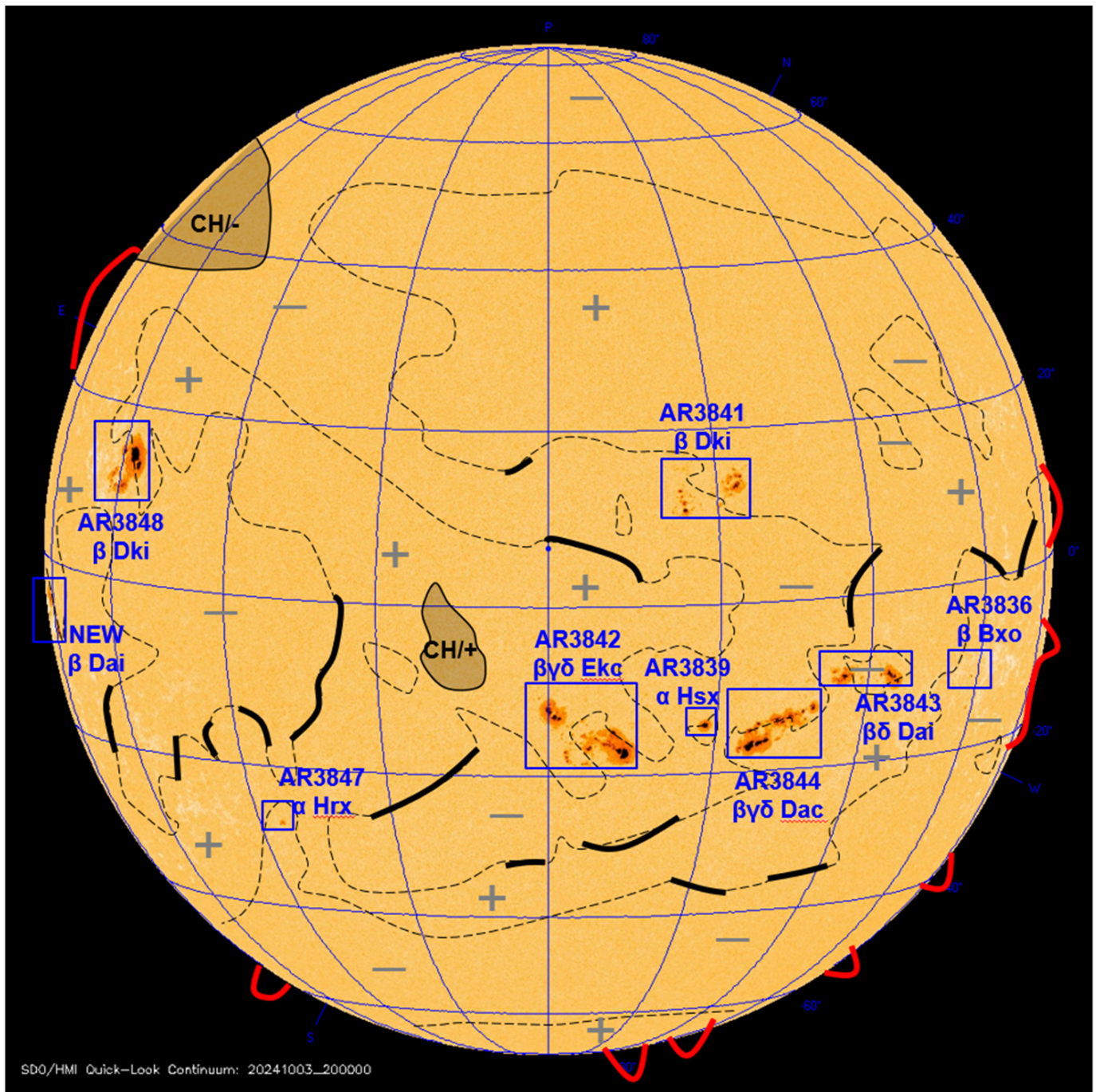
Solar Activity: Solar activity is expected to be Moderate, with further M-class flares expected and a chance of returning to High should another isolated X-class flare occur, these most likely originating from AR3842 or AR4844.

Solar Wind / Geomagnetic Activity: The expected glancing CME from 29 Sep appears to have missed Earth. A glancing blow from the X7.1 flare CME is likely on days 1 or 2 (04-05 Oct). The arrival of a CME from the 3rd Oct X9.0 flare is more confidence, arriving either late on the 5th or early on the 6th Oct.

Quiet (Kp 0-2) geomagnetic conditions are expected at first, increasing G1-G2 (Kp 5-6) at times from late today or early tomorrow and through the rest of the period, due to the arrivals of the X7.1 CME and then the X9.0 CME. There is also a chance of G3 (Kp 7) conditions occurring, mainly from late on day 3 (5th) into day 4 (6th), with a slight chance of isolated G4 (Kp 8) intervals.

Energetic Particles / Solar Radiation: High energy proton flux at GOES18 is forecast to persist at background with a chance of rising above should further significant flares occur. High energy electron flux at GOES16 is expected to persist at Background to Moderate levels. The associated 24 hour fluence is expected to remain below the Active threshold (1e8 total pfu), throughout.

Figure 1: Solar Analysis 03/2000 UTC



Key: Filament __, Prominence __, Magnetic Field Line ---, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - $\beta\gamma$ - $\beta\gamma\delta$ and Zurich-McIntosh Axx etc.

Geomagnetic Storms

The expected glancing CME from 29 Sep appears to have missed Earth. A glancing blow from the X7.1 flare CME is likely on days 1 or 2 (04-05 Oct), as the CME appears to mostly head to the south of Earth. The arrival of a CME from the 3rd Oct X9.0 flare is more confidence, with a more direct hit expected, arriving either late on the 5th or early on the 6th Oct.

Quiet (Kp 0-2) geomagnetic conditions are expected at first, increasing G1-G2 (Kp 5-6) at times from late today or early tomorrow and through the rest of the period, due to the arrivals of the X7.1 CME and then the X9.0 CME. There is also a chance of G3 (Kp 7) conditions occurring, mainly from late on day 3 (5th) into day 4 (6th), with a slight chance of isolated G4 (Kp 8) intervals due to the combined effect of both CME arrivals.

Geomagnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	50	70	80	80
Strong	G3	No	10	30	50	50
Severe	G4	No	1	5	20	20
Extreme	G5	No	1	1	5	5

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R _☉ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
30/1545	Partial	Filament	SW	1500	03/0300UTC	Glancing blow. Low confidence.
02/0938	Partial	AR3842	SE	800	04/2300 UTC	Low confidence based on estimates. +/- 12hrs arrival time.
03/1637	Full	AR3842	SW	882	05/1800 UTC	High confidence for being Earth directed, lower confidence arrival time.

Radio Blackouts - X-Ray Flares

There are currently eight numbered active regions on the visible disc. The most complex regions are both in the southwest quadrant; AR3842 with an obvious delta spot within the larger leader spot, and AR3844, which has recently gained penumbra and developed two small delta spots. AR3841, located in the northwest, previously contained an elongated delta spot in the trailing portion. However, this region has recently decayed to a beta configuration. AR3848, close to the northeast limb, remains the largest region on the disc, with one large leader followed by several trailing portions, but classification still remains low confidence due to the foreshortening effect. The remaining numbered regions are smaller and appear relatively benign. However, a new region appearing on the east limb looks potentially large and complex, with at least two spots with penumbra, but is too close to the limb for accurate analysis.

Solar activity has been High, with the background X-ray flux just below M-class levels. The largest flare was a X9 flare observed at 03/1218 UTC, which originated from AR3842 near south-centre disc. A M6.7 flare also occurred at 03/2028 UTC from AR3843. Solar activity is expected to be Moderate, with further M-class flares expected and a chance of High should another isolated X-class flare occur. The risk of strong flares comes mostly from AR3842 or AR3841, with forecast values held higher than raw probabilities due to the high background x-ray flux level, past events and the strength and positioning of delta spots in each of the aforementioned sunspots.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	85	85	85	85
Very Active	R3-R5 (X Class)	Yes	35	35	35	35

Figure 2: X-Ray Flux for the past 24 hours

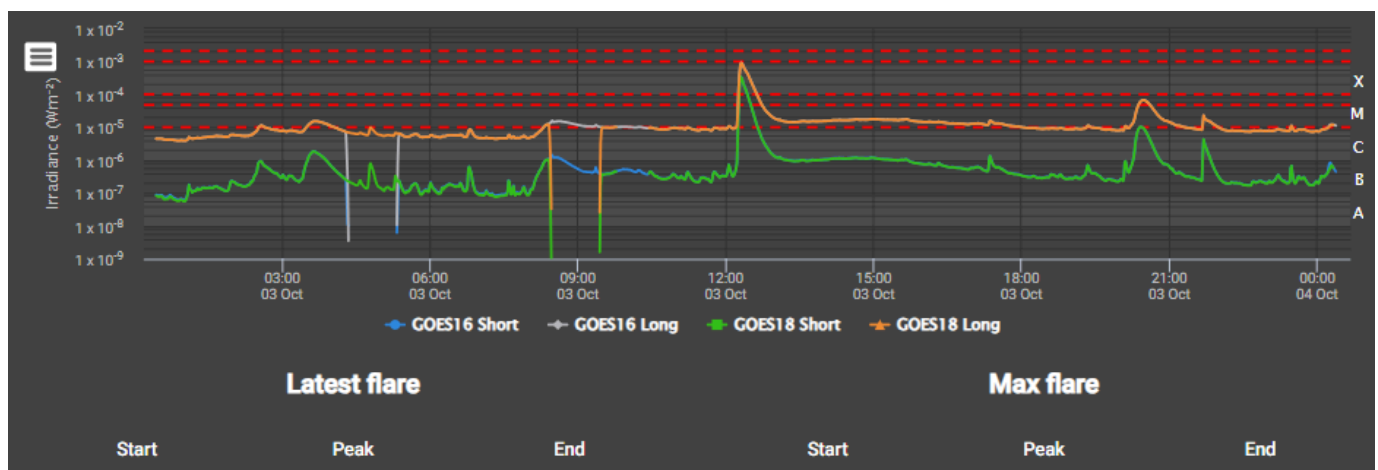
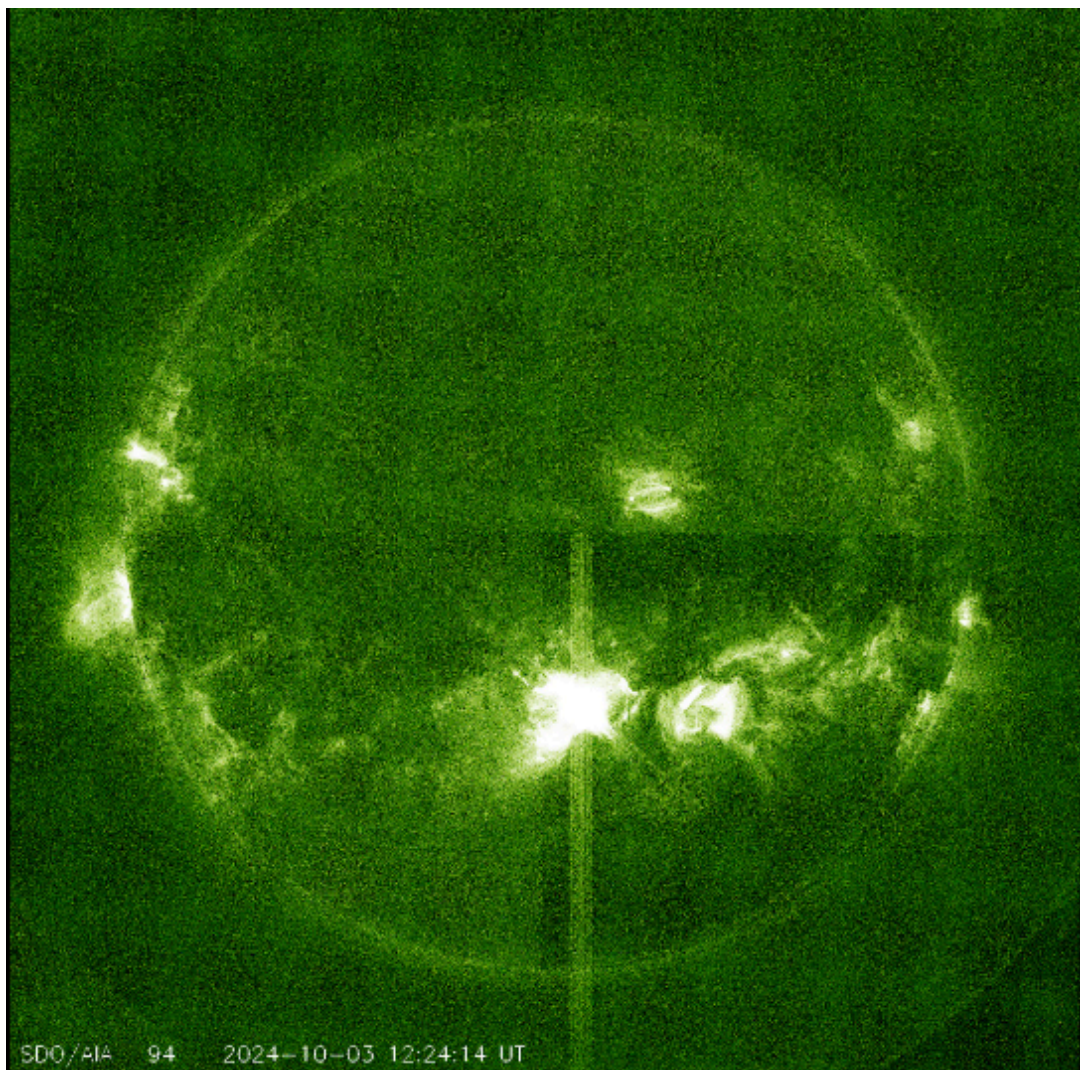


Figure 3: SDO AIA 94 image showing the X9.0 flare, with the image being overwhelmed by the flux levels.



Solar Radiation Storms (High Energy Protons)

High energy proton flux at GOES18 is forecast to persist at background levels. No notable proton enhancement was observed following the X7.1 flare and associated CME. There is a continued chance of Proton rich flares, mainly from AR3842 or AR3844, along with notable filaments on the disc also posing a risk should they erupt.

Radiation Storms	Level (cm ⁻² sr ⁻¹ s ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	20	20	20	20
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = cm ⁻² sr ⁻¹ s ⁻¹)						

High Energy Electrons ($\geq 2\text{MeV}$)

High energy electron flux (greater than 2MeV) observed by GOES16 was at background to Moderate levels (at diurnal peak), with a similar trend expected through the four day period.

The associated 24 hour fluence is forecast to stay below Active ($1\text{e}8$ total pfu), in agreement with MOSWOC REFM.

GEO Electron Environment	Level ($\text{cm}^{-2}\text{sr}^{-1}\text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2\text{ MeV}$ $\geq 1\times10^8$	No	1	1	1	1
Very Active	$\geq 2\text{ MeV}$ $\geq 1\times10^9$	No	1	1	1	1

Figure 4: MOSWOC REFM model

